

### **REMARKS**

Claim 31 has been amended to particularly point out and distinctly claim the embodiment in accordance with the present invention that is described by this claim. No new matter has been added.

Applicants respectfully request that the present application be reconsidered and the claims allowed for the following reasons.

### **The Invention**

The present invention pertains broadly to a process for fabricating a semiconductor device that has a support member, such as a lead frame, to which a semiconductor die or chip is attached using a die-bonding material. More particularly, the first preferred embodiment in accordance with the invention is a process for fabricating a semiconductor device characterized by the step of bonding a semiconductor device to a support with an organic die-bonding film at conditions of temperature 100-250°C and pressure of 0.1-30 gf/mm<sup>2</sup>, wherein the organic die-bonding film has a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher, to produce a bonded chip. All of the remaining dependent claims represent other preferred embodiments that are modifications of the first preferred embodiment.

The advantage of the claimed invention and the various modifications is that a process is provided for the manufacture of semiconductor devices that have fewer flow cracks and other defects that devices made with silver paste have because the fabrication process of the present invention produces semiconductor devices that are less prone to formation of reflow cracks during the fabrication process. Thus, the semiconductor devices made by the process of the

claimed invention are more reliably manufactured and have better durability than semiconductor devices manufactured by the prior art fabrication processes.

### **The Rejections**

Claim 31 stands rejected under 35 U.S.C. 112, second paragraph, as indefinite. Claims 25-30, 33, 36, 48, 49, 52, 55, 58-60 and 63-65 stand rejected under 35 U.S.C. 102(a) as anticipated by, or in the alternative under 35 U.S.C. 103(a) as unpatentable over, Morita et al. (U.S. Patent 5,406,124). Claims 31, 32, 34, 35, 37, 38, 50, 51, 53, 54, 56, 57, 61, and 62 stand rejected under 35 U.S.C. 103(a) as unpatentable over Morita in view of Hozoji (Japanese document JP5-218107). Claims 39, 42, and 45 stand rejected under 35 U.S.C. 103(a) as unpatentable over Morita in view of Sakumoto (U.S. Patent 5,277,972). Claims 40, 41, 43, 44, 46 and 47 stand rejected under 35 U.S.C. 103(a) as unpatentable over the combination of Morita and Hozoji, and further in view of Sakumoto.

Applicants traverse the Examiner's rejection for the following reasons.

### **Applicant's Arguments**

As an initial matter, Applicants assert that claims 25-65 are in compliance with 35 U.S.C. 112.

The Morita reference discloses an "insulating adhesive tape" that includes a base supporting film and an adhesive layer formed on at least one surface thereof (see Abstract). The adhesive layer is a thermoplastic polymer comprising a thermoplastic polyimide, wherein the polymer has a glass transition temperature ranging from 180°C to 280°C and an elastic modulus

ranging from  $10^{10}$  dyne/cm<sup>2</sup> to  $10^{11}$  dyne/cm<sup>2</sup> at 25°C, wherein the elastic modulus includes a value ranging from  $10^2$  dyne/cm<sup>2</sup> to  $10^9$  dyne/cm<sup>2</sup> at a temperature between 250°C and 300°C.

The Morita reference also discloses that the adhesive temperature for bonding IC chips to lead frames using the adhesive tape is selected from the range of 250-450°C (preferably 270-400°C) and the adhesive pressure is 1-50 kg/cm<sup>2</sup> (preferably 5-30 kg/cm<sup>2</sup>), (col. 14, lines 3-14). However, the presently claimed invention recites bonding conditions to include the combination of a bonding temperature of 100-250°C and a bonding pressure of 0.1-30 gf/mm<sup>2</sup> as recited in independent claim 25.

Furthermore, Applicants point out that the Examiner notes that the Morita reference does not disclose a die-bonding film having a "17 degree peel strength of 0.5 Kgf/5mm x 5mm chip or above" (Office Action, dated December 26, 2001, page 6, lines 1 to page 7, line 2), but the Examiner asserts that in the absence of unexpected results that such an increase in peel strength would be "ascertainable by routine experimentation and optimization" (Office Action, dated December 26, 2001, page 6, lines 13-17). However, the Examiner does concede that "a disclosure that the limitations...produce an unexpected result, or are otherwise critical" would rebut any established prima facie case of obviousness (Office Action, dated December 26, 2001, page 6, line 20 to page 7, line 2).

#### **Rebuttal of Examiner's Anticipation Rejection**

The Examiner asserts that the Morita et al. reference anticipates, under 35 U.S.C. 102(a), the subject matter of independent claim 25 of the present invention. However, the courts have held that to establish lack of novelty under 35 U.S.C. 102 the asserted anticipating reference must identically describe every element in the claims, and the burden is for the Examiner, not the Applicant, to show that every element of the claims is identically described in the asserted

anticipating reference. Continental Can. Co. USA Inc. v Monsanto Co., 20 USPQ2d 1746, 1748 (Fed. Cir. 1991). Furthermore, where the asserted anticipating reference fails to explicitly teach a certain characteristic, the disclosure must be sufficient to show that the characteristic at issue flows as a natural result from the teachings of the reference. *Id.* at 1749.

In the present case, the Examiner has made no effort to show that Morita et al. discloses a process recited in claim 25 that includes bonding with “an organic die-bonding film...wherein the organic die-bonding film has a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher.” In other words, for the Morita et al. reference to anticipate the subject matter of claim 25, Morita et al. must teach a die-bonding film used for bonding as in the recited process wherein the die-bonding film has the property of a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher. As stated by the Examiner himself, “[i]n particular, Morita does not appear to explicitly teach that the process results in a peel strength of 0.5 kgf/(5 mm x 5mm chip) or higher” (Office Action dated December 24, 2002, page 10, lines 4-6). Applicants agree.

To assert that the Morita et al. reference anticipates the subject matter of instant claim 25, it is the Examiner's burden to explicitly point out where in the Morita et al. reference there is sufficient disclosure to show that bonding with a die-bonding material having a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher is the natural result flowing from the teachings of the Morita et al. reference. This the Examiner cannot do for two reasons. First, the Examiner has rightly pointed out that the required peel strength is not necessarily present in the die-bonding film disclosed by the Morita et al. reference (Office Action dated December 24, 2002, page 10, lines 6-11). Second, the Rule 132 Declaration by Masuko, (hereafter, the “Masuko Declaration”), filed June 25, 2002, provides clear factual evidence in Table 1 to show that a die-bonding film made in accordance with the teachings of the Morita et al. reference does not have

a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher. In other words, the factual evidence provided in Table 1 of the Masuko Declaration destroys any inherency argument.

**Rebuttal of Examiner's Obviousness Rejection**

The Examiner asserts that the Morita et al. reference renders obvious, under 35 U.S.C. 103(a), the subject matter of independent claim 25 of the present invention. Applicants disagree.

The thrust of the Examiner's argument appears to be that Morita et al. teaches it would be "desirable" to manufacture a stronger die-bonding film, from which the Examiner concludes that such a desire renders obvious the manufacture of a die-bonding film, having the recited peel strength, as used for bonding in claim 25 (Office Action dated December 24, 2002, page 10, lines 16-20). The Examiner argues that it would be a matter of routine optimization and well known manufacturing constraints to manufacture the particular die-bonding film having the required peel strength property as used in the process of instant claim 25 (Office Action dated December 24, 2002, page 10, lines 16-20).

Applicants disagree with the Examiner's conclusion because it is precatory. The Examiner's argument expresses the desirability of a making a die-bonding film having the claimed peel strength property but does not provide any factual support from the Morita et al. reference, or from another source, as to how such a die-bonding film could be manufactured. The Examiner attempts to fill in the gaps by arguing that "well known manufacturing constraints" could be applied to the teachings of the Morita et al. reference, and that by the use of these "manufacturing constraints" the die-bonding film having the required properties would emerge "by optimization and routine experimentation" (Office Action, dated December 24, 2002, page 10, lines 16-20). Such statements appear conclusory as based on a desire to achieve a certain result and appear to lack evidentiary support from the prior art. Thus, Applicants assert that the

Examiner has not properly established a rejection under 35 U.S.C. 103(a) because the record does not reflect a factual basis establishing bonding with a die-bonding film having a "peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher" as recited in the process of claim 25.

Even if one were to assume that the Morita et al. reference does suggest a die-bonding film having the required peel strength property, which is not a valid assumption, Applicants have provided factual evidence of unobvious, unexpected results in the Masuko Declaration that overcomes any prima facie case of obviousness.

### **Unexpected and Superior Results**

The Masuko Declaration establishes that when the novel film (see Section 7 on page 3) in accordance with the present invention is compared to the prior art film (see Section 6 on page 3) disclosed by Morita et al. under identical experimental conditions, the result is that the novel film of the present invention demonstrates an "unexpected invulnerability" (page 7, lines 4-8). As shown in Table 2, when evaluating the two films for the occurrence of reflow cracks it was shown that while all of the Morita film samples under the given die-bonding conditions manifested reflow cracks, none of the samples made in accordance with the present invention had reflow cracks.

In addition, when peel strength was measured (Masuko Declaration, section 8) the peel strength was significantly greater for the novel film of the present invention over the Morita film (see Table 1). In fact, when the die-bonding condition was set as "250°C x 30gf/mm<sup>2</sup> x 20 sec," all of the chips made using the novel film were destroyed during testing because the bond strength was stronger than the chip. In other words, the bond strength of the film material in accordance with the present invention was stronger than what this particular test could measure! Clearly, this is another superior and unexpected result.

In view of the Masuko Declaration, the prima facie case of obviousness standing against independent claim 25 has been sufficiently rebutted to be overcome by the factual results, which includes the superior and unexpected result of the die-bonding film having "a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher" as recited in claim 25.

**Sufficiency of the Masuko Declaration**

The Examiner asserts that the Masuko Declaration is "insufficient" for the following reasons: (a) "it refers only to the system described in the application and not the individual claims of the application," (b) "the objective evidence of nonobviousness is not commensurate in scope with the claims," (c) "it does not compare the claimed invention with the closest prior art," (d) there is no conversion factor between the 90 degree peel strength property taught by Morita et al. and the 17 degree peel strength property used in the Masuko Declaration so no 17 degree peel strength comparison can be made between a die-bonding film disclosed by Morita and a die-bonding film provided by the present invention, and (e) the Morita et al. reference teaches unexpected results at col. 7, lines 65-68, that renders the results provided by the present invention as "not unexpected" (Office Action, dated December 24, 2002, page 16, line 1, to page 17, line 11).

The Examiner argues that the Masuko Declaration is insufficient because it does not refer to individual claims in the application and cites MPEP 716 as supporting authority (Office Action, dated December 24, 2002, page 16, lines 1-5). Applicants traverse the Examiner's position on the basis that MPEP 716 does not require the declaration itself to refer to individual claims. The burden is now placed on the Examiner to show where in the MPEP there is a requirement that the declaration itself refer to any individual claims. The courts require only that "the objective evidence of nonobviousness ...be commensurate in scope with the claims." In re

Clemens, 206 USPQ 289, 296 (CCPA 1980). In the present case the evidence is clearly commensurate in scope with the claims.

The Examiner argues that the Masuko Declaration is insufficient because the objective evidence of nonobviousness is not commensurate in scope with the claims (Office Action, dated December 24, 2002, page 16, lines 6-11). In particular, the Examiner argues that the showing of unexpected results have not been determined to occur over the entire claimed range and cites In re Clemens at 296 in support of this position. Applicants point out that the Examiner has misapplied In re Clemens in the present case.

In Clemens, the condensate polishing process set forth in claims 1-7 and 9-10 differed from the prior art only by the utilization of VBC-based resins, whereas the prior art used CME-based resins. Both parties maintained that the two kinds of resins had very similar structure and that one skilled in the art would have substituted one for the other as prima facie obvious. The unexpected results of comparative testing of the two kinds of resins demonstrated that in the temperature range of 110°C to 130°C the VBC-based resins were significantly more thermally stable than the CME-based resins; however, as recited in the base claim 1 the phrase “elevated temperature” that was interpreted to include temperatures of 60°C, where CME-based resins were thermally stable. Therefore, the court concluded that the probative value of the narrow range of data could not be reasonably extended to prove unobviousness of the broader range of “elevated temperature” that included 60°C. On the other hand, the court held that the comparative data did prove that claim 8, which recited “at a temperature in excess of 100°C,” was unobvious over the prior art. In re Clemens, 206 USPQ 289 (CCPA 1980).

In the present case, one of ordinary skill in the art would readily appreciate that the objective evidence provided in Table 1 of the Masuko Declaration is commensurate in scope



with claim 25. Specifically, the three sets of temperature and pressure die-bonding conditions tabulated in Table 1 of the Masuko Declaration all fall within the temperature and pressure condition ranges recited in claim 25. In addition, only the 17 degree peel strengths of the organic die-bonding film bonded in accordance with the process of claim 25 achieved the required peel strength of 0.5 kgf/(5 mm x 5mm chip) or higher. On the other hand, the organic die-bonding film made in accordance with the teachings of the Morita et al. reference failed to achieve a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher. The facts of the present case are similar to claim 8 in Clemens, which is the claim the court concluded was allowable because it recited temperature conditions that were within the experimental temperature conditions provided in the Rule 132 Declaration. In view of the facts, and in view of the analysis of Clemens, it is clear that the objective evidence presented in Table 1 of the Masuko Declaration is commensurate in scope with claim 25.

The Examiner argues that Applicants have not compared the present invention to the closest prior art (Office Action, dated December 24, 2002, page 16, lines 12-21). Specifically, the Examiner argues that the closest prior art would be identical to the present invention because Morita et al. lists an "identical polyimide" to the present invention (Office Action, dated December 24, 2002, page 16, lines 14-17). The courts have held that when comparative data is presented, there is no requirement that the Applicant compare "the results of the invention to the results of the invention." In re Chapman, 148 USPQ 711, 714 (CCPA 1966). In other words, whether or not the Morita et al. reference lists polyimides (col. 11, line 13 to col. 13, line 55) that are identical to one or more of the polyimides listed in the present specification (page 16, line 16 to page 17, line 6, and page 10, line 1 to page 14, line 24) is immaterial. The courts have held that when one of ordinary skill in the art must pick and choose from the various subject matter

contained in a single disclosure, the reference cannot be properly used to support a lack of novelty rejection, but may support an obviousness rejection. In re Arkley, 172 USPQ 524, 526 (CCPA 1972). To overcome any prima facie obviousness rejection, Applicants are required to compare the invention to the closest prior art, but not to the invention itself. In re Chapman, 148 USPQ 711, 714 (CCPA 1966). As stated in the Rule 132 Declaration, Applicants believe they have compared the invention to the closest prior art, being Example 1 of the Morita et al. reference (Masuko Declaration, page 3). It makes no sense for applicants to be required to pick and choose from long lists of components to “invent” something to compare their invention to. Applicants have compared the invention to the closest embodiment actually disclosed, which is shown in the examples that is all that Chapman and the other relevant case law requires them to do.

The Examiner argues that “the claimed result cannot be declared unexpected in relation to peel strength of Morita when the relationship between the peel strength of Morita cannot not be determined” (Office Action, dated December 24, 2002, page 17, lines 5-9). Applicants do not require a continuation factor because they have made an actual experimental comparison and found Morita inferior! The fact there is no conversion factor between the 90 degree peel strength disclosed by Morita and the 17 degree peel strength disclosed by Applicant is immaterial to the results provided in the Masuko Declaration. Specifically, the Masuko Declaration provides a direct comparison between the 17 degree peel strengths of the die-bonding film made in accordance with the present invention to the closest prior art die-bonding film disclosed by Morita. Because the Masuko provides a direct factual comparison there is no need to rely upon inferences drawn from the Morita reference. In fact, the data provided by the Masuko reference shows that any inferences drawn about peel strengths from the Morita reference in support of an

obviousness rejection are erroneous. The die-bonding material disclosed by the Morita reference is plainly weaker than the die-bonding material used for bonding in accordance with the conditions recited in claim 25 of the present invention.

Lastly, the Examiner asserts that the Morita reference teaches unexpected results of the magnitude shown in the Masuko Declaration (Office Action, dated December 24, 2002, page 17, lines 9-11). Applicants respectfully disagree. The Examiner relies upon the following statement in Morita as a teaching of unexpected results:

“However, the treatment effect in the thermoplastic polymer layer of the present invention is remarkable beyond expectations. The adhesive strength to the substrate can be improved and stabilized greatly.” (col. 7, lines 65-68).

The Examiner’s reliance is upon mere puffery while the reference may claim its material has great strength, the actual evidence shows that the present invention is superior. This section contains no factual information that could be used to negate the superior and unexpected adhesive properties provided by bonding with the die-bonding film in accordance with the present invention. There is nothing in the Morita et al. reference to teach, or even suggest, that the bond is so strong that the chips shatter before the adhesive gives way. The present invention truly achieves adhesion that “is remarkable beyond expectations.”

For all of the reasons argued above, Applicants assert that the Masuko Declaration is sufficient to overcome any prima facie obviousness rejection in view of the Morita et al. reference.

Applicants incorporate herein the arguments made previously in Amendment (B) filed June 25, 2002, and in Supplemental Response to Amendment (B) filed October 11, 2002.

Applicants specifically reiterate the following.

Hozoji discloses a “resin-sealed semiconductor device” wherein a die pad and a semiconductor element are fixed by using an adhesive layer in which a base material having a low moisture absorption rate (i.e. glass cloth or metal foil) is impregnated or coated with a bisphenol type epoxy resin, wire bonded, and with resin containing one or more of epoxy, phenol or polyimide resins (see Abstract). The Hozoji reference is silent with respect to the property of peel strength.

The Sakumoto et al. reference discloses an “adhesive tape” for electronic parts wherein the adhesive tape includes a heat resistant base film, and an adhesive layer laminated on at least one side of the base film, the adhesive layer comprising a resol type phenol resin and an acrylonitrile/butadiene copolymer (see Abstract). Sakumoto et al. is silent with respect to the property of peel strength.

To reiterate, the Morita et al. reference cannot anticipate, or render obvious, the subject matter of base claim 25 because Morita et al. does not teach, or even suggest, (a) the “organic die-bonding film has a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher,” and (b) the combination of conditions of “temperature 100-250°C and pressure of 0.1-30 gf/mm<sup>2</sup>.”

However, even if a prima facie case of obviousness can be inferred from the teachings of Morita (which it can not), it is plainly shown that the present invention provides superior and unexpected improvements in both peel strength and reflow crack development over the Morita et al. adhesive tape. Specifically, the peel strength of the novel film in accordance with the present invention is consistently and significantly stronger than the peel strength of the Morita et al.

film, and in some cases the peel strength of the instant novel film was so strong that it could not be fully measured using the present techniques. In addition, the novel film in accordance with the present invention was “unexpectedly invulnerable” to the formation of reflow cracks, whereas 100% of the Morita films developed reflow cracks.

### **Conclusion**

Neither the Morita et. al. reference, nor the Hozoji et al. reference, nor the Sakumoto et al. reference teach that “the organic die-bonding film has a peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher” as recited in claim 25. Therefore, the prima facie case of obviousness is untenable and should be withdrawn. Furthermore, even if a prima facie case of obviousness could be reasonably established (which it can not), the experimental evidence provided by the Masuko Declaration clearly demonstrates unobvious and unexpected results pertaining to the invention of claim 25, thereby sufficiently rebutting and overcoming the rejection.

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For all of the above reasons, claims 25-65 are in condition for allowance, and prompt notice of allowance is earnestly solicited. Questions are welcomed by the below-signed attorney for applicants.

Respectfully submitted,

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**VERSION WITH MARKINGS TO SHOW CHANGES MADE**

**IN THE CLAIMS:**

31. (Amended) A process according to claim 30, wherein said step of bonding comprises bonding with an organic die-bonding film further having a void volume of 10% or less in terms of voids present in the material of the film, and at an interface between said film and said support at a stage where the semiconductor has been bonded to said the support member by said the film.